

# 🌟 WELCOME TO PART 2 OF CELL BIOLOGY!



Master Notes • Structural Breakdowns • Deep Facts

## 1. THE THREE MAIN REGIONS OF A CELL 🌍

No matter how much cells vary, they all have 3 major functional zones:

- **Plasma Membrane / Cell Membrane** (and Cell Wall in plants) - The outer boundary.
- **The Nucleus** - The brain and command center, which is often visible under a regular light microscope.
- **The Cytoplasm** - The jelly-like fluid where all cell machines (organelles) float. Most of these tiny internal structures can only be seen with a powerful Electron Microscope.

### 💡 Fascinating Fact - EUTELY:

Most multicellular organisms have an indefinite number of cells (like humans with around 100 trillion or  $10^{14}$  cells)! However, in some special organisms like rotifers and nematodes, the number of cells is fixed after embryonic development. They grow big not by making more cells, but by stretching their existing cells. This phenomenon is called **Eutely**.

## 2. THE OUTER BOUNDARIES

### A) The Plasma Membrane: The Cell's Security Guard

- **Nature:** Outer covering of every single cell. It is living, thin, delicate, elastic, and *selectively permeable*.
- **Thickness:** Tiny! Only about 7 nm (70 Å) thick.
- **Chemical Makeup:** 75% Phospholipids + Proteins + Cholesterol + Polysaccharides.
- **Homeostasis:** Controls what goes in and out to maintain a constant internal environment.

#### The Fluid Mosaic Model (1972):

- Proposed by scientists **Singer and Nicolson**, this is the most accepted model.
- It is made of a double layer (bilayer) of fat molecules called phospholipids.
- They famously described the membrane as *"A number of protein icebergs floating in a sea of lipids"*.
- **Proteins:** Intrinsic proteins span across the entire bilayer, while Extrinsic proteins sit on the inner or outer surface. These proteins act as enzymes, transport proteins/permeases, pumps, and receptor proteins.
- **Flexibility:** The fluid nature of the lipids and proteins gives the membrane flexibility, which is crucial for processes like engulfing food (endocytosis).

### B) The Cell Wall (Plants Only!)

- **Nature:** Found outside the plasma membrane in plant cells. It is a tough, non-living, and rigid layer.
- **Permeability:** Unlike the plasma membrane, it is freely permeable and lets almost anything pass through.
- **Composition:** Made primarily of a fibrous carbohydrate called **cellulose** (microfibrils glued by pectins and hemicellulose).
- **Functions:** Provides definite shape, protects the plasma membrane/cytoplasm, prevents water loss (desiccation), and provides mechanical strength for plant support.

### 3. HOW SUBSTANCES MOVE ACROSS THE MEMBRANE

Cells constantly need to take in food/oxygen and throw out waste. The plasma membrane regulates this using different methods:

#### A) DIFFUSION (Passive - No Energy Needed)

- Spontaneous movement of molecules from a **High Concentration** region to a **Low Concentration** region until evenly spread.
- Faster in gases than liquids/solids.
- Example in cells: Small substances like Carbon dioxide (CO<sub>2</sub>) and Oxygen (O<sub>2</sub>) move this way.  
When CO<sub>2</sub> builds up inside a cell, it automatically diffuses out. When O<sub>2</sub> is low inside, it diffuses in.

#### B) OSMOSIS (Passive - Only for Water!)

Movement of water molecules from a region of high water concentration to low water concentration through a semi-permeable membrane. Osmosis uses zero energy!

| Solution Type              | Water Concentration         | Effect on Cell                                                                                                                      |
|----------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <b>Hypotonic Solution</b>  | More water outside the cell | Water enters the cell. Cell swells up and becomes turgid. Red Blood Cells (RBCs) can swell and burst (Haemolysis).                  |
| <b>Isotonic Solution</b>   | Equal water inside & out    | No net movement of water. Cell stays the exact same size (E.g., Ringer's solution).                                                 |
| <b>Hypertonic Solution</b> | Less water outside the cell | Water leaves the cell. Plant cells undergo Plasmolysis (living part pulls away from wall), Animal cells shrink/wrinkle (Crenation). |

#### C) MEDIATED TRANSPORT (Special Help)

Some molecules are too big or insoluble to pass through the lipid layer. They need special membrane proteins called **Permeases** to create a passageway.

- **Facilitated Transport:** No energy needed. Protein acts as a slide to help molecules diffuse downhill (E.g., Glucose entering body cells).

- **Active Transport:** Moves molecules "uphill" against the concentration gradient. It needs Energy (ATP) and special carrier proteins called Pumps (E.g., Sodium-Potassium pump in animals).

## 4. ENDOCYTOSIS: HOW CELLS SWALLOW STUFF

Endocytosis means the cell takes in materials by folding its membrane inward to form a pocket. **This requires energy.**

- **Phagocytosis ("Cell eating"):** Cell engulfs solid food or large particles. E.g., Amoeba eating food, or our White Blood Cells (Leucocytes) eating bad bacteria!
- **Potocytosis ("Cell drinking"):** Taking in small molecules or ions by creating tiny pits.
- **Receptor-mediated Endocytosis:** A smart way where specific large molecules (ligands) bind to receptors on the cell surface before the cell folds them in.

## 5. EXOCYTOSIS: CELL VOMITING

- The exact opposite of endocytosis! The cell expels waste or secretes useful things (like hormones and enzymes).
- A waste/secretory vesicle moves to the surface, its membrane fuses with the plasma membrane, opens up, and throws the contents out of the cell.
- Used to remove undigested food and transport antibodies.